



This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

### Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

- + *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
- + *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
- + *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
- + *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

### About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at <http://books.google.com/>

QC

1

U582s

NO. 98

B 1,063,775

DEPARTMENT OF COMMERCE AND LABOR

BUREAU OF STANDARDS

S. W. STRATTON, Director

REMARKS ON THE QUARTZ COMPENSATING  
POLARISCOPE WITH ADJUSTABLE  
SENSIBILITY

BY

FREDERICK BATES

*Bureau of Standards*

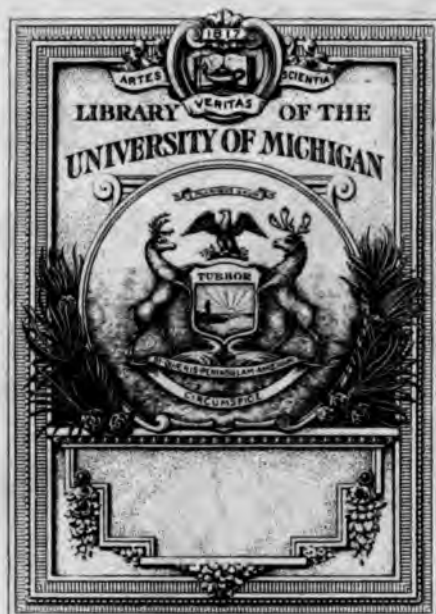
[JUNE 2, 1908]

REPRINT NO. 98

(FROM BULLETIN OF THE BUREAU OF STANDARDS, VOL. 5, NO. 3)



WASHINGTON  
GOVERNMENT PRINTING OFFICE  
1908



363

**DEPARTMENT OF COMMERCE AND LABOR**  
**BUREAU OF STANDARDS**  
S. W. STRATTON, Director

---

**REMARKS ON THE QUARTZ COMPENSATING  
POLARISCOPE WITH ADJUSTABLE  
SENSIBILITY**

BY  
**FREDERICK BATES**  
*Bureau of Standards*

[JUNE 2, 1908]

**REPRINT NO. 98**  
(FROM BULLETIN OF THE BUREAU OF STANDARDS, VOL. 5, NO. 2)



WASHINGTON  
GOVERNMENT PRINTING OFFICE  
1908





Doc. (Acad.)  
 May Public  
 5-21-32  
 3232:9

QC  
 1  
 45825  
 no. 98

## REMARKS ON THE QUARTZ COMPENSATING POLARISCOPE WITH ADJUSTABLE SENSIBILITY.

By Frederick Bates.

In an article on a "Quartz Compensating Polariscopes with Adjustable Sensibility," which appeared in the Bulletin of the Bureau of Standards (Vol. IV pp. 461-466), the writer discussed the effect on the zero reading of the scale when the Polarization angle  $\alpha$  was varied. In general, the intensities of the light emerging from the large and small nicols of a Lippich polarizing system are unequal. Hence, when the analyzing nicol is set for equal intensity of the halves of the field its position is different from what it would have been had the beams been of equal intensity. The angular difference,  $\delta$ , between the two positions of the analyzing nicol was obtained from the equation

$$\tan \delta = \pm \frac{\sqrt{K} - 1}{\sqrt{K} + 1} \tan \frac{\alpha}{2} \quad (3)$$

$$\text{where } K = \frac{A_2}{A_1}$$

and is the ratio of the intensity of the light emerging from the small nicol of the polarizing system to that emerging from the large nicol.

We have for a Lippich system

$$A_2 = f(A_1 \cos^2 \alpha, M) \quad (5)$$

where  $A_1 \cos^2 \alpha$  is the intensity of the light from the small nicol, if there has been no other loss than that due to the partial crossing of the large and small nicols.  $M$  is the algebraic sum of the effects of all the remaining factors upon which the relative inten-

sities of  $A_1$  and  $A_2$  depend. These factors are quite numerous. Among them may be mentioned absorption, depolarization, the inclination of the small nicol to the axis of the system, the relative inclination of the faces of the small nicol, the positions of diaphragms, and reflection as the light enters the small nicol. It is evident that  $M$  is a constant for a particular instrument, but varies with different polarizing systems. For this reason, and because it is a simple matter for the instrument makers to correct for it, the quantity  $M$  was neglected in discussing  $\delta$  in the paper referred to above.

In "Bemerkungen zu der vorstehenden Batesschen Arbeit,"<sup>1</sup> Dr. Otto Schönrock calls attention to the fact that the writer has not taken the reflection and absorption in the small nicol into consideration in calculating  $\delta$  from (3), inasmuch as the equation

$$A_1 = A_2 \cos^2 a \quad (6)$$

was used to obtain  $K$ . Schönrock modifies (3) in the following manner:

From the well-known Fresnel equations, when light at perpendicular incidence passes from one refracting medium into a differently refracting medium, the fraction

$$B = \left[ \frac{n-1}{n+1} \right]^2 \quad (7)$$

is reflected. Applying (7) to the case of air and Iceland spar, where  $n = 1.486$ , and neglecting (6), Schönrock finds that

$$A_2 = A_1 \left[ 1 - \left( \frac{n-1}{n+1} \right)^2 \right]^2 \quad (8)$$

$$= A_1 \cdot 0.925 \quad (9)$$

There is therefore a loss of 7.5% by reflection at the faces of the small nicol. A further allowance of 0.005 was arbitrarily made for the loss due to absorption in the small nicol. Thus, he finds, by considering the losses due to the crossing of the large and small nicols and to reflection and absorption, that

---

<sup>1</sup> Zs. Ver. Zuckerind, Feb., 1908, p. 111.

$$A_2 = 0.92 A_1 \cos^2 a \quad (10)$$

and

$$\tan \delta = \frac{1 - \sqrt{0.92} \cos a}{1 + \sqrt{0.92} \cos a} \tan \frac{a}{2} \quad (11)$$

In Table I is shown a comparison of the values of  $\delta$  given by (3) and (11).

TABLE I.

$a$	$\delta$ IN SUGAR DEGREES.	
	From Equation (3).	From Equation (11).
$5^\circ$	0.014	0.164
$10^\circ$	0.111	0.412
$15^\circ$	0.378	0.830

The values from (11) are markedly larger than those from (3). It is to be remembered that (11) takes into consideration the effect on  $\delta$  of the loss in intensity due to reflection and absorption in the small nicol, but neglects all the other factors of  $f(M)$ . It will be observed for any value of  $\delta$  that the value from (11) equals the value from (3) increased by  $0.03a$ .

Hence,

$$\delta = \tan^{-1} \left[ \pm \frac{\sqrt{K} - 1}{\sqrt{K} + 1} \tan \frac{a}{2} \right] + 0.0103a \quad (12)$$

$$= \tan^{-1} \left( \tan^2 \frac{a}{2} \right) + 0.0103a \quad (13)$$

Equation (13) holds for all working values of  $a$  and is significantly simpler than (11). A consideration of the remaining factors involved in  $f(M)$  would result in decreasing the constant, 0.0103 (=0.03 for  $\delta$  in sugar degrees). It is thus evident that if  $f(M)$  be taken into account the only effect on the value of  $\delta$  given by (3) is to change it by  $\pm Ca$  where  $C$  is a constant for each individual Lippich system.



